Role of Entomopathogenic Fungi in Insect Pests Control of Field Crops

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Introduction

In recent years, crop protection based on biological control of crop pests particularly with microbial pathogens like viruses, bacteria, fungi and nematodes has been recognized as a valuable tool in pest management. Among them entomopathogenic fungi have a potential role to play in development of future integrated pest management strategies. They are effective, ecofriendly, biodegradable and do not leave any harmful residue on environment so it is used widely. *Agostino Bassi* in 1835, first time used the white muscardine, fungus on the silk worm that was the named in his honour as *Beauveria bassiana*. Pesticides have done a lot of good for the world food supply but their unilateral utilization has created many problems *viz.,* development of resistant, resurgence, outbreak of pest and pesticide residues.

In this context, use of entomopathogenic fungi has come into vogue, having target selectivity environmental compatability, economic variability, novel mode of action, safer to environment and beneficial organisms as well as rational approach at a long run.

Why do we need Entomopathogenic fungi?

- The conventional use of chemical pesticides has not only enhanced the food production, but also adversely affected the environment and non-target organisms.
- Increasing cases of insects developing resistance, e.g., *Helicoverpa* has become resistant to most of the insecticides.
- Due to the side-effects of chemical pesticides, also to demand the sustainable crop production through eco-friendly pest management is essentially in recent scenario.
- So, alternative methods of insect management offer adequate levels of pest control and pose fewer hazards.

Symptoms of fungal infection

- Loss of appetite, irritability and paralyses
- Discoloured patches on integuments and increased acidity in blood
- The body hardens and covered by dense white and green mycelial mat
- Mummified larvae comply to leaves, stem and fruiting body with upright position on its prolegs at the time of death
- Death occurs with 3-6 days depending on host insect and environmental condition.

Mode of infection

Spore of fungus come in contact with the cuticle (skin) of insects, they germinate and penetrate in cuticle either by germ tube or by infection pegs from appresoria and grow directly through the cuticle to the inner body of their host. The fungus proliferates throughout insect's body, producing toxin and draining the insect nutrients, eventually kiliing it. Death is caused by tissue destruction and occasionally by toxins produced. Once fungus has killed its host, it grows back out through the softer portion of cuticle, covering the insect with a fungal growth.

- When spores of the fungus come in contact with cuticle of insects, they germinate and penetrate the cuticle by germ tube form appresoria and grow directly throught the cuticle.
- Fungus proliferates throughout the insect's body, producing toxins and draining the insect of nutrients, eventually killing it.
- Death caused by tissue damage and toxin produced by fungus.

General characteristics of Entomopathogenic fungi

- It occurs naturally in soils throughout the world
- It reproduces sexually and asexually
- It has usually definite cell wall
- Growth rate moderately rapid
- Colony reaches a diameter of 3 cm
- Incubation time seven day
- Produces creamy white colour growth

Effect on Field crops

Beauveria bassiana Vuillemin

- Karkar *et al.* (2014) found that the most effective dose (3.5 g/l) of *B. basiana* against third instar larvae of *Helicoverpa armigera* Hubner in pigeonpea.
- Chandrayudu *et al.* (2015) evaluated the efficacy of botanical and microbial insecticides against *S. litura* infesting groundnut and reported that *B. bassiana* (1.5 x 10^{13} spore/ml) was significantly effective in reducing larval population. Combination of chloropyriphos @ 0.125% + *B. bassiana* @ 1 x 10^{7} cfu/g caused 86.27 per cent mortality of rice hispa. (Puzari *et al.,* 2015).
- Kankale *et al.* (2015) found that spraying of *B. bassiana* (1.0 x 10^{4} spore/ml) with neem soap @ 0.5% recorded minimum population of *H. armigera* and pod damage on chickpea.
- Lower per cent of rosette flowers per plant was recorded in treatment of *B. bassiana* 1.15 WP @ 0.009% and was statistically at par with chlorantraniliprole 18.5 SC @ 0.006% and spinosad 45 SC @ 0.014% against pink bollworm in cotton. (Anonymous, 2016[a]).

- Annamalai *et al.* (2016) reported that *B. bassiana* (1 x 10^{13} spore/ml) can be play an effective role in eco-friendly management of *Thrips tabaci,* higher mortality at 7 DAT was observed in cotton. Higher larval mortality (50 per cent) of fall army worm on maize crop was observed by spraying of *B. bassiana* 1.15 WP (1 x 10^{8} cfu/g) 40 gm and neem oil (10000 ppm) 20 ml/10 liter water. (Anonymous, 2018)

***Lecanicillium lecanii* Zimmerman viegas**

- Patil *et al.* (2012) found that the higher dose of *Verticillium lecanii* @ 7.50 kg/ha proved to be the effective against thrips, leaf hopper and aphid in cotton. Mer *et al.* (2016) observed that after one day insecticidal spray of *V. lecanii* @ 1.25 kg/ha + thiomethoxan 25 SG @ 0.05% was found most effective, showed 41.11 per cent mortality of groundnut jassid.
- Patel *et al.* (2019) studied the effect of different entomopathogenic fungi against mustard aphid and reported that *L. lecanii* @ 60 g and *B. bassiana* @ 60 g/ 10 liter of water proved most effective against aphid.

***Metarhizium anisopliae* Metchnikoff**

- Manisegaran *et al.,* (2011) evaluated *M. anisopliae* @ 4 x 10^{9} conidia/ha recorded significantly lower population of whitegrub in sugarcane. Rana and Kachhawa (2014) reported that *M. anisopliae* @ 1 kg enriched with FYM @ 1 t/ha found lower plant mortality due to termite in maize.
- Soil application of *M. anisopliae* @ 5 kg with 250 kg/ha FYM was found most effective against sugarcane whitegrub. **(**Anonymous, 2016[b]).
- Application of *M. anisopliae* @ 2 kg enriched with vermicompost @ 1 t/ha and *M. anisopliae* @ 2 kg enriched with castor cake @ 1 t/ha were found lower plant mortality of groundnut at 80 days after germination with less population of whitegrub/ 1 m row length at harvest. **(**Anonymous, 2019)

***Nomuraea rileyi* Samson**

- Three sprays of *N. rileyi* @ 1 x 10^{8} conidia/ ml were significantly effective in suppressing the larval population of *S. litura* (1.2 larvae/plant) with 62.5 per cent mortality in soybean. (Anonymous, 2012)
- Sharmila and Manjula (2015) revealed that groundnut oil based formulation of *N. rileyi* recorded significantly higher reduction in larval population of *S. litura* in groundnut.

Compatibility with insecticides

- Bagwan *et al.,* (2012) showed that azardirachtin 1000 ppm, carbosulfan 25 EC and fenvalerate 10 EC did not significantly reduce the spore germination of *M. anisopliae* and *B. bassiana.* Barad *et al.,* (2014) evaluated the compatibility of *N. rileyi* with insecticides and concluded that azadirachtin @ 0.0075% and spinosad @ 0.009% were found compatible.
- Lily (2016) evaluated the compatibility of *B. bassiana* and *N. rileyi* with different insecticides and observed that spinosad 45 SC @ 0.02% and imidacloprid 17.8 SL @ 0.04% were compatible.

- Reddy (2016) observed that fipronil 40 + imidacloprid 40 WG @ 0.04% and monocrotophos 36 SL @ 0.036% were not significantly reduce the spore germination of *M. anisopliae, L. lecaanii* and *B. bassiana,* respectively.
- Kachot *et al.,* (2018) evaluated the compatibility of *B. bassiana* with insecticides and found diamethoate 30 EC @ 0.015%, dianotefuran 20 SG @ 0.005% and spinosad 45 SC @ 0.007% were not significantly reduce the spore germination of *B. bassiana.*

Advantages

- The Major advantage of exploiting microorganisms for pest control is their environmental safety primarily due to the host specificity of these pathogen.
- Microorganisms have natural capability of causing disease at epizootic levels due to their persistence in soil and efficient transmission.
- There is minimum effects on non-target organism.
- The cost of development and registration of microbial insecticides is much less than chemical insecticides.
- Their application is relatively easy and inexpensive in most cases.
- Generally, resistance in insect to pathogens is not developed as compared to other insecticides**.**

Conclusion

- The entomopathogenic fungi control many insect pests *viz*; sucking (aphids, jassids, thrips, *etc*.), foliage feeders (pod borer, leaf eating caterpillar, semi looper, *etc*.) and soil borne insects (whitegrub and termite).
- Entomopathogenic fungi are safe for non-target organism, good compatibility with adjuvant, insecticides (azardirachtin, spinosad, imidacloprid and dianotefuran) and considered as natural mortality agent in insect pest management programmes.
- Use of entomopathogenic fungi should be emerged as promising alternative to chemical pesticides.
- Commercial products of entomopathogenic fungi are available in market that can be utilized as one of the component of IPM.

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